Final Report
X-Ray Spectra of Starburst Galaxies
for NASA Grant: NAG5-1864

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1 Summary

This is the final report to the National Aeronautics and Space Administration (NASA) concerning NASA grant NAG5-1864. This grant was awarded to Dr. C. Megan Urry of the Space Telescope Science Institute in response to a proposal, entitled "X-Ray Spectra of Starburst Galaxies." The grant was originally awarded in February 1992 and was fully expended as of September 1994.

The purpose of this project was to use Rosat PSPC spectra to determine the origin of the X-ray emission in starburst galaxies, to unravel the relative importance of AGNs and massive stars to the energetics of starburst galaxies, and to help determine the contribution of starburst galaxies to the X-ray background.

Our original proposal included four starburst galaxies; in AO2 we were awarded time to observe one of these (NGC3310). Some of our collaborators (Heckman, Dahlem) were awarded additional Rosat time, on separate proposals, to observe other starburst galaxies. In the spirit of the original proposal, we agreed to combine forces in some way to best present our results.

In the meantime, we used the funding for this grant to pay for a Science Data Analyst to reduce the Rosat observations of NGC3310 and to help Dahlem with his analysis of the additional Rosat targets.

We found that the soft X-ray flux is well-fitted with a Raymond-Smith model with $kT = 0.4$ keV, and the total X-ray luminosity is $\sim 3.2 \times 10^{40}$ ergs s^{-1} in the PSPC band. This is a somewhat softer spectrum than observed in other starburst galaxies, possibly hinting at the presence of large amounts of gas at $\sim 5 \times 10^6$ K.

The spectral decomposition into contributions from hard X-ray binaries and from thermal gas was not well defined, unfortunately, but the nuclear soft-X-ray flux is marginally resolved by the PSPC. We therefore proposed (successfully) in AO5 to obtain Rosat HRI images of NGC3310, in order to separate nuclear and extended components, such as those found in other starburst galaxies in our larger sample. We are now waiting for these data to be obtained. We expect to publish our Rosat PSPC results collectively with the HRI results.

In this same time period, we have done some related work on Rosat data, which has educated us about PSPC spectra and which is relevant to the study of the contributions of AGN to starburst X-ray spectra; specifically, investigations of the soft-X-ray (PSPC) spectra of Seyfert 2 galaxies (Turner et al. 1994) and of the superluminal quasar 3C345 (Unwin et al. 1994).

2 Bibliography

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